

## ***Myotis septentrionalis* Trouessart (Northern Long-eared Bat) Records from the Coastal Plain of North Carolina**

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**Abstract** - *Myotis septentrionalis* (Northern Long-eared Bat) is a small, insectivorous bat found in the eastern United States and Canada. Along the east coast, its range is thought to extend as far south as the Great Dismal Swamp in coastal Virginia. We captured six *M. septentrionalis* in the northern coastal plain region of North Carolina. Field identification was based on characters of ear and tragus length and confirmed with mitochondrial cytochrome *c* oxidase subunit I sequences. These captures signify the presence of a resident population of *M. septentrionalis* in the northern coastal plain of North Carolina. Future work is needed to document range limits and hibernation behavior of this species in the piedmont and coastal plain of North Carolina.

### **Introduction**

*Myotis septentrionalis* Trouessart (Northern long-eared Bat; Fig 1.) is a small insectivorous bat found in the eastern United States and Canada. *Myotis septentrionalis* was formerly thought to be a subspecies of *M. keenii* (Merriam) (Keen's Myotis; Miller and Allen 1928), but is now recognized as a distinct species (van Zyll de Jong 1979). *Myotis septentrionalis* is distinguished from other *Myotis* species by its large ear, that, when laid forward, extends beyond the muzzle and its long, pointed tragus (Caceres and Barclay 2000).

*Myotis septentrionalis* hibernates in caves and abandoned mines during the winter, where it is commonly observed swarming (Caceres and Barclay 2000). Copulation occurs in hibernacula prior to winter, and females store sperm and fertilize a single egg in the spring. During the summer months, *M. septentrionalis* uses trees as day-roosts (Caceres and Barclay 2000). *Myotis septentrionalis* is a small and maneuverable bat that hunts within cluttered forest stands (Carroll et al. 2002, Owen et al. 2003) in both upland (Harvey et al. 1999, Lacki and Schwierjohann 2001, Sasse and Pekins 1996) and floodplain forests (Carroll et al. 2002, Foster and Kurta 1999). *Myotis septentrionalis* is known to hunt flying insects and also glean insects from substrates (Faure et al. 1993).

*Myotis septentrionalis* occupies much of the eastern United States and Canada, but is most common within Ontario, Quebec, and the New England states (Caceres and Barclay 2000). However, its range extends south into

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Alabama and Georgia, and west into Alberta, British Columbia, Montana, and Wyoming (Caceres and Barclay 2000), and the species can be locally common in these regions. Along the east coast, the range is thought to extend as far south as the Great Dismal Swamp in coastal Virginia (specimens: AMNH 93177 and USNM 23277, see Appendix 1 for full names; Webster et al. 1985). Previous distribution maps suggesting a presence in the North Carolina coastal plain (Caceres and Barclay 2000) are drawn broadly and are based on few actual records. Although the Great Dismal Swamp extends into North Carolina, recent surveys have found no evidence of *M. septentrionalis* in the coastal plain of North Carolina (Clark 1999, Lambiase et al. 2002, McDonnell 2001). Records of *M. septentrionalis* in North Carolina are mainly from the western portion of the state, with the exception of one isolated record in the piedmont (NCSM 45; Fig. 2) and one reportedly in the southern coastal plain (David Webster, University of North Carolina, Wilmington, NC, pers. comm.; Fig. 2).

### Methods

During the summer of 2007, we captured bats using mist-nets at the Tidewater Research Station, located in the coastal plain 5 miles east of Plymouth in Washington County, NC. We captured six *M. septentrionalis* in mist-nets set along a closed-canopy, overgrown road corridor directly adjacent to a natural forested wetland area surrounded by intensively managed *Pinus taeda* L. (Loblolly Pine). Field identification to species included measurements



Figure 1. Individual juvenile female *M. septentrionalis* (ID ADM35 from Table 1) captured in the northern coastal plain of North Carolina during summer 2007.

and characters of ear and tragus length (Table 1; Fig 1). We also collected tissue samples from wing membranes, and all bats were released at site of capture. We did not mark captured bats in any way. However, because we collected a wing biopsy, we could tell if individuals were recaptures based on either the presence of the biopsy site or scarring over the biopsy site. Capture and handling protocols were approved by the UNCG Institutional

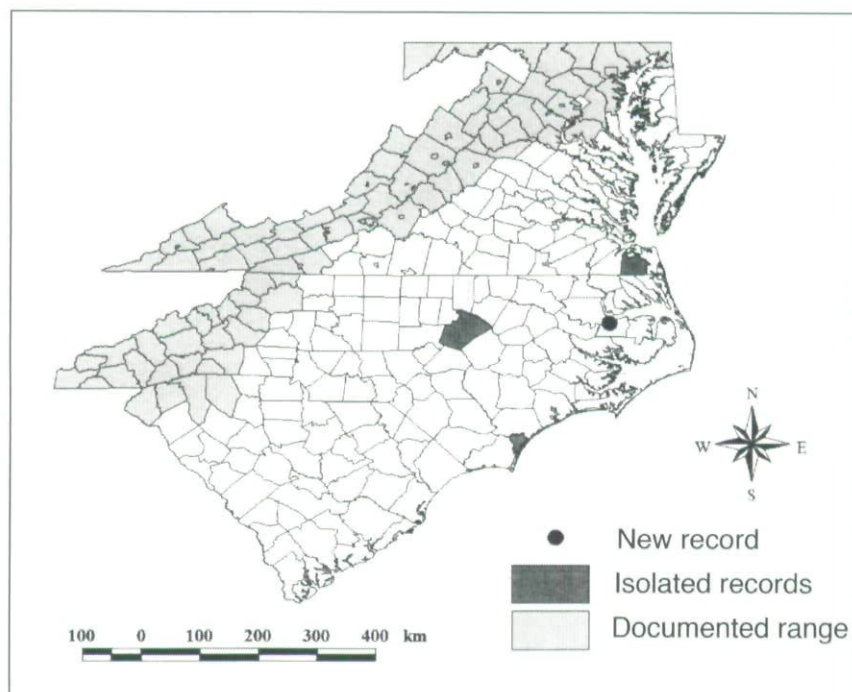


Figure 2. Map showing the range of *M. septentrionalis* in North Carolina, South Carolina, Virginia, and Maryland. Shaded counties contain documented records of *M. septentrionalis*; the filled black circle represents our capture site. Map was generated using a map layer compiled by Bat Conservation International (available at <http://nationalatlas.gov/mld/bat000m.html>) and a compilation of local records (D. Webster, pers. comm.).

Table 1. Measurements of the six individuals of *M. septentrionalis* captured in the northern coastal plain of North Carolina during summer, 2007. Measurements of length were taken with standard metric calipers and measurements of mass taken with a Pesola® spring scale.

ID	Date	Time	Sex	Age	Forearm (mm)	Ear (mm)	Weight (g)
ADM31	6/11/2007	10:15 PM	Male	Adult	33	n/a	4.95
ADM34	6/18/2007	9:38 PM	Female	Juvenile	34	16	4.95
ADM35	6/18/2007	11:40 PM	Female	Juvenile	34	16	5.45
ADM36	6/25/2007	9:50 PM	Female	Juvenile	36	n/a	5.95
ADM41	6/25/2007	2:15 AM	Male	Juvenile	36	15	5.50
ADM50	7/2/2007	10:05 PM	Female	Juvenile	35	n/a	5.45



Animal Care and Use Committee (# 06-11) and complied with recommendations of the American Society of Mammalogists.

To confirm species identification, we compared mitochondrial cytochrome *c* oxidase subunit I (COI) sequences from these six bats to those of *M. septentrionalis* collected elsewhere and to other eastern North American bats in the genus *Myotis* that are also found in North Carolina (Fig. 3, Appendix 2). We obtained partial COI sequences (bidirectionally sequenced) using primers and cycling conditions outlined in Hebert et al. (2003), and cleaned and aligned sequences using CodonCode Aligner 2.04 (CodonCode Corporation, Dedham, MA), resulting in a final fragment length of 636 bp. We estimated sequence divergences by using the Kimura-2-Parameter distance model and graphically displayed these in a neighbor-joining tree using PAUP (v. 4.0b10; Swofford 2002).

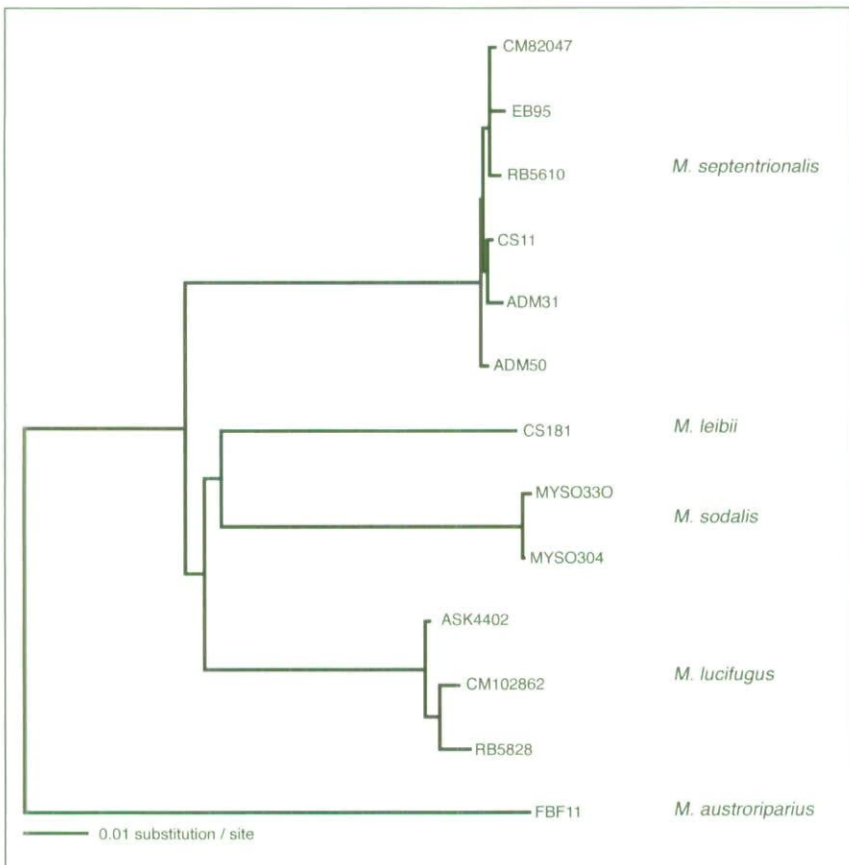


Figure 3. Neighbor-joining phylogram of COI sequences based on Kimura 2-parameter distances, showing the specimens from Washington County, NC (two unique haplotypes among the six specimens, labeled ADM31 and ADM50) grouping with other *M. septentrionalis* samples from other parts of the range. Details of specimens included can be found in Appendix 2.

## Results and Discussion

Five of the six bats captured in North Carolina shared identical haplotypes (ADM31 through ADM41; see Table 1, Figure 3). Four *M. septentrionalis* specimens (CM82047, CS04, JJ43, UAM68932) from various locations shared the same haplotype (Fig. 3). The two *M. austroriparius* specimens (FBF11 and AM168) shared the same haplotype (Fig. 3). Mean sequence divergence between the two unique haplotypes observed in North Carolina and other *M. septentrionalis* specimens (4 unique haplotypes) was 0.4%, while sequence divergence with other eastern North American *Myotis* averaged 9.7% (ranging from 8.5% with *M. lucifugus* to 13.8% with *M. austroriparius*). The two haplotypes from North Carolina clearly grouped with other *M. septentrionalis* in the neighbor-joining analysis (Fig. 3), confirming identification of the six bats.

The six bats we captured represent both adult and juveniles (young of the year in 2007), suggesting reproduction of these bats in this area. These six bats were captured mid-breeding season (11 June through 2 July) on 4 different nights at the same mist-net site, suggesting that these were not migrating individuals. Thus, based on seasonal timing of adult and juveniles captured over multiple nights, we suggest that these *M. septentrionalis* signify a resident population of this species in the northern coastal plain of North Carolina as opposed to stray captures.

This population is 96 km further south of the Great Dismal Swamp localities in Virginia. The area where these bats were captured reflects habitat preferences of this species in other parts of its range (Carroll et al. 2002, Harvey et al. 1999, Owen et al. 2003). That is, these bats were captured in a mist-net strung across an overgrown roadway adjacent to mature forest stands. However, our captures were not in close proximity to cave hibernacula. *Myotis septentrionalis* are thought remain close to hibernacula during summer foraging (Caceres and Barclay 2000). Since no caves exist in the coastal plain of North Carolina, our captures imply that these bats either 1) travel much further to hibernacula than previously thought; 2) utilize alternative hibernacula, such as tree cavities; or 3) do not hibernate during the mild winters in this area. In the coastal plain, *M. septentrionalis* may hibernate in tree cavities or buildings, like *Corynorhinus rafinesquii* (Lesson) (Rafinesque's Big-eared Bat) (Trousdale and Beckett 2005, Trousdale et al. 2008).

Future work is needed to document range limits of this species and to fill in gaps between the location in our study and known locations of the species to the north and west. Future studies should also examine hibernation behaviors of *M. septentrionalis* in the piedmont and coastal plain of North Carolina.

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**Appendix 1.** Full names of museum acronyms for specimens listed in text and not used in the genetic analysis.

AMNH = American Museum of Natural History.

NCSM = North Carolina State Museum of Natural Sciences.

USNM = National Museum of Natural History.

**Appendix 2.** Locations of specimens used in the genetic analyses. Voucher specimens used in this study were housed in the Carnegie Museum of Natural History, Pittsburgh, Pennsylvania (CM), the Angelo State Natural History Collection, San Angelo, TX (ASK), and the University of Alaska Museum, Fairbanks, AK (UAM). Additional wing membrane samples were used, and housed at Western Michigan University (all other abbreviations).

*Myotis austroriparius* – UNITED STATES. South Carolina: Francis Beidler Forest, Dorchester County (FBF11). Georgia: Climax Cave, Decatur County (AM168).

*Myotis leibii* – UNITED STATES. West Virginia: North Fork Mountain, Pendleton County (CS181).

*Myotis lucifugus* – UNITED STATES. Montana: Flathead National Forest, 0.5 mi NW of Swan Lake, Lake County (ASK4402). West Virginia: Babcock State Park, 0.2 miles S, 0.3 miles W of Clifftop, Fayette County (CM102862). Nebraska: Guadalcanal Prairie, 5.7 miles S and 3.5 miles W of Harrison, Sioux County (RB5828).

*Myotis septentrionalis* – UNITED STATES. Kentucky: Bangor, Rowan County (EB95). Maryland: Owens Creek campground, Catoctin Mountain Park, Frederick County (JJ43). Nebraska: Walnut Creek, 3.9 mile N and 4.4 miles W of Newcastle, Dixon County (RB5610). West Virginia: Monongahela National Forest, 3 miles N, 4.5 miles W of Harmon, Randolph County (CM82047). North Fork Mountain, Pendleton County (CS04). Camp Creek State Forest and Park, Mercer County (CS11). CANADA. British Columbia: Smith River, N of Alaska Highway (UAM68932)

*Myotis sodalis* – UNITED STATES. Tennessee: White Oak Blowhole Cave, Blount County (MYSO304). Virginia: Cumberland Gap Saltpeter Cave, Lee County (MYSO330).



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